

ANNALS OF NATURAL HISTORY.

XXXV.—*On the Writings of Goethe relative to Natural History.* By M. F. G. PICTET*.

THE labours of Goethe in natural history had for their object comparative anatomy, botany, and geology. All bear the stamp of the loftiness of conception and profoundness of view which are characteristic of genius ; they treat of the most important, but also sometimes of the most disputed points of organization ; we would therefore confine ourselves to the part which we can best appreciate, and chiefly point out the services he has rendered to comparative anatomy. But previously, and in order to explain how and to what extent Goethe was an anatomist, it is indispensable to take a slight view of his life and the epoch of his labours.

Born and reared at Frankfort on the Maine, Goethe directed his first studies, as he himself tells us, to the knowledge of ancient and modern languages. His literary taste displayed itself early, and some poetical essays completed these first labours. No circumstance had ever as yet led him to study nature, and at most a vague desire of acquiring a knowledge of her laws now and then crossed his mind. “ Here and there in my poetical essays,” says he in the sketch which in 1831 he gave of his botanical studies, “ are to be perceived some traces of a passionate love for the country, and of an earnest desire to penetrate the great secret of the constant creation and annihilation of beings ; but this desire evaporated in vain and useless contemplations.”

It was at Strasbourg, in 1770, that he first set about the study of the natural sciences. Having come to this city to take the degree of doctor of laws, he gave to this pursuit so much time only as was strictly necessary, and followed with ardour courses of chemistry, anatomy, medicine, and even of

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midwifery. He returned to Germany with a very decided taste for these sciences, a taste which his abode at Weimar still continued to cherish. Living much in the country in the midst of a society of learned men, making frequent botanical excursions, and availing himself of every opportunity of improving and exercising his talent for observation, he made himself acquainted with the principal phænomena of vegetation, and from this epoch is to be dated the origination of his principal ideas of botanical organography.

He describes himself afterwards as working at Jena with ardour at the collections of comparative anatomy, the importance of which for instruction was more and more felt; the collections of that city still contain several preparations from his hands. By this means he acquired an exact and detailed knowledge of animal forms, and laid up for himself important materials for his subsequent labours. "I sawed," said he, "and cleaved bones and skulls in every direction, in order to obtain foreseen or unforeseen lights on the structure of bones." And indeed osteology was the department of zoology with which afterwards he was principally occupied. At this period he became the rival and friend of the anatomist Loder, and from that time he hardly ever ceased working at comparative anatomy, either to learn what had been done before him, or to extend the boundaries of the science and suggest improved methods. Fourteen memoirs or notices, composed from 1786 to 1832, bear witness to his continued interest for this study. His memoirs, however, did not always meet with an encouraging reception. Thus, when he had drawn up an account of his discovery of the intermaxillary bone in man, he sent it to Camper, who praised him for the composition, gave him advice about the drawings, but did not admit the results. Blumenbach also refused to admit its truth. In spite of the formidable disapprobation of two of the most celebrated anatomists of Germany, Goethe was not discouraged; but it was not till forty years afterwards that his ideas on the intermaxillary bone were adopted by all naturalists. This is unfortunately the history of most of the discoveries which swerve from the track of generally received ideas.

Goethe was very tenacious of his reputation as a naturalist,

and was particularly desirous that the results to which he had come should not be attributed to a brilliant imagination, but that they should be regarded as the fruits of long and earnest labours. He concludes the history of his botanical studies with these words: "For half a century and more I have been known as a poet in my own country and even to foreigners, and no one dreams of denying me this talent. But what is not so generally known, what has not been sufficiently taken into consideration, is that I have worked earnestly and for a long time at the physical and physiological phænomena of nature, that I have observed in silence with the perseverance which devotion alone can give. Also when my Essay on the knowledge of the Laws of development of the Plant, printed in German forty years ago, excited attention, first in Switzerland, then in France, people knew not how to express their astonishment, that a poet, usually occupied with intellectual phænomena, which are from the fountain of sentiment and imagination, turning an instant from his course, had by the way made so important a discovery. It is to controvert this mistaken notion that this preface has been written. It is intended to show that I have devoted a great part of my life to the study of natural history, to which I was drawn by a passionate taste. It was not by the sudden and unexpected inspiration of a genius endowed with extraordinary faculties, it was by continued studies, that I arrived at this result."

Thus then we may look upon Goethe as a true naturalist, who, if he had not had so great a reputation as a poet, would long since have been quoted amongst the men of science, for whom Germany is illustrious. He advanced science, and well understood its requirements. He studied with ardour the facts upon which it rests, and, as he himself tells us, he arrived at general laws by a comparison of details. Assuredly we do not wish to deny the share which the strength of his imagination may have had; this noble gift has in general been the endowment of all those who have advanced science by new conceptions and felicitous theories. But we no longer live in an age, when theories, which are but the produce of this faculty, brilliant as it may be, can be regarded as a progress. The imagination is to be admitted only when it generalizes facts,

when it deduces consequences from them, and by these means throws a vivid light upon a subject which without its aid would have remained inert and obscure. It was this species of imagination that directed the labours of Goethe. It is the glory inherent in its results that he lays claim to ; a glory which we shall justify by an inquiry into the services which he has rendered this science, and into the manner in which he has viewed some of the important questions which have been debated in these latter years.

It was natural for Goethe, a German and a poet, to set out from the principle of the unity of organic composition in its widest acceptation ; and in fact, the greater part of his labours were directed to the demonstration of this law, which tends every day more and more to become the basis of comparative anatomy. In this respect he preceded all the naturalists of his age ; he has indeed been outstripped since, and some German anatomists have gone much further in this path, at that time new. Time will show whether they have proceeded in it with as much success. Goethe quickly perceived that anatomical determinations were tainted with a diversity opposed to the progress of the science ; he felt that a rallying point was wanting for these conclusions, that they must be uniform in all animals, and that, without this principle, confusion and the want of a rule must necessarily make the study of comparative anatomy difficult and even impossible. He was not slow in observing that this rallying point was the principle of unity of organic composition, and that the discovery of this law must alter the face of the science, by giving it for a basis the unity which reigns in nature. It was he, it seems, who if he did not catch the first glimpse, at least, who first clearly comprehended this important fact. But he did not immediately publish his ideas upon this subject, so that the constant progress of science led to its being discovered in the interval, in France, by Geoffroy St. Hilaire. The regeneration of comparative anatomy set out then at the same time from these two countries ; and if these discoveries have brought on such animated debates, we should, I think, only attribute them to the too great promptitude which the innovators have been desirous of displaying, for the principle of unity of or-

ganic composition can no longer be denied within certain limits: the labours of those even who have opposed it when it was put forth in all its generality, are grounded upon this principle in a more confined view. All discussion at the present day can have for its object only the fixing these limits, and we do not think that the state of the science will admit of this being done with any security.

Setting out from these principles, the illustrious author, of whose works we are giving an analysis, published some memoirs which may be referred to two classes. The first relates to the method which should serve as a guide in the researches of comparative anatomy. The second is the discovery of some particular facts having a relation to the demonstration of the principle. In the first class we shall principally quote the memoir entitled, *On the necessity of the establishment of a Type in order to facilitate the study of Comparative Anatomy*. The ancient method, which consists in comparing man with animals and these with one another, is lengthy, destitute of fixed principles, and has only led to incomplete results. It is necessary with regard to each species to note the differences and resemblances to others; and although the natural methods have greatly facilitated these comparisons by diminishing the number of beings to compare, still one may say with Goethe, that comparative anatomy, viewed in this manner, is "a work impossible, infinite, which, if by a miracle it should one day be accomplished, would be without results as without limits."

The notion of an ideal type, created, by abstraction, from the assemblage of the parts common to all animals, supposes a philosophical survey of organization as a whole, puts in evidence, at the outset, the prominent points, allows all descriptions to be reduced to the comparison of the species to the type, by this very means makes it possible to compare all these descriptions with one another, and thus the labour becomes easier and more philosophical. The possibility of creating this type flows from the law of unity of organic composition; and the idea of the type is nothing else than the perfect conception of this law; for if we suppose the organs analogous and similarly arranged, this state and this arrangement in common, considered as an abstraction made from individual forms

and variations, naturally constitute the type, which accordingly cannot be confounded with any species more than the whole can be confounded with a part.

It may be conceived how much such a method is preferable to that, so frequently employed, of taking man as a type, when his very perfection makes him, in most cases, very unfit for this purpose.

The creation of the type necessarily varies according to the objects of comparison. If we wish to study a particular class, the type may be more defined, the characters in common being more numerous. The type the most difficult to establish will be the animal type, for to seize it perfectly, it will be necessary to have a perfect idea of the parts common to all animals, or in other words, to have exhausted the study of analogies. Thus the establishment of types will be a feeling our way, and the perfect type the result of the science at its zenith, as the imperfect type will be the amount of this science at some certain period, and the basis upon which it will lean in order to continue its progress.

The type being once created, Goethe applies himself to its comparison with individual forms, and, in this analysis, sets out from the principle that diversity has no other origin than this; that, in the development, one part becomes predominant at the expense of some other, and *vice versâ*. He admits with respect hereto the influence of surrounding media and of exterior causes generally, by the force of which the nutritive matter is directed in superabundance and under certain forms to particular parts, so as to produce there a hypertrophy, always followed by an atrophy in some other part of the same being, because the nutritive matter is diverted from it to the gain of the former. He supposes that a certain formative or *plastic* force is given to every being, and that if it be directed to one point the consequence must necessarily be inverse modifications with regard to the others*. “The general total,” says he, “in the

* To make this idea intelligible to those who are little accustomed to these theories, I shall cite the instance of the reptiles, in which we see the plastic force sometimes direct itself upon the vertebræ, sometimes upon the feet. Starting from the lizard, as a mean point, we come on one side to the frog, in which the feet, by an excessive development, subject the ribs to atrophy; and on the other side we find the serpent, in which the develop-

budget of nature is fixed ; but she is free to dispose of particular sums by any appropriation that may please her. In order to spend on one side, she is forced to economize on the other, and nature can therefore never run in debt nor become bankrupt." It is easy here to recognise the principle put forth by M. Geoffroy Saint Hilaire under the name of the *balance of organs*.

These considerations may be applied in two ways ; either in the comparing of beings with one another, and the result of this observation is to show the general type modified by the above law according to the part which the species acts in nature and the medium in which it dwells ; or in comparing with each other the different parts of the same being, a study in which the same balance is perceived, and which leads to generalizations of a more difficult character and included generally under the name of *the law of homology*. We shall here leave these discussions concerning the type, and shall not follow the author in the applications he makes of them when he produces the model of an osteological type for the Mammiferae, and analyses the variations of the bones and the characters by which they may be known ; an analysis of high importance from its applications, but which would carry us beyond our intended limits.

Under the second head, that of special labours, we always discover the same drift and the same philosophical views. One of the most generally known is the discovery of the *intermaxillary bone* in man. It is known that most of the Mammiferae have both sides of the upper jaw formed of two bones, the one external and largest, which contains the molar and canine teeth, and which is the *maxillary* properly so called ; the other internal, smaller, which contains the incisors, and which has received the name of the *incisive* or *intermaxillary* bone. These two bones are not separate in man at the adult age.

The naturalists of the past century had eagerly laid hold of

ment of the ribs brings with it the disappearance of the feet. This latter example has even this remarkable circumstance, that all the transitions are to be seen, at first in the *Scincidae*, which have more ribs than the lizards and smaller feet ; then in the *Sepsidae*, which have almost the ribs of serpents and the rudiments of feet ; and lastly in *Anguis*, which comes still nearer to the serpents, and whose limbs are not externally visible.

this fact as tending to establish that man and the animals have not a common structure. Feeling what an immense distance separates man from the rest of the creation, they sought with care for all the differences of organization by which this distance could be increased; not perceiving that these details of structure are nothing in comparison with differences of a higher order, which alone can establish an impassable barrier. Goethe understood and demonstrated that in this particular, as in others, the organic materials which constitute the body of man are the same as those which compose that of animals. He proved that man, at every age, shows traces of the bipartiteness of the bones of the jaw, and that it is possible by certain criteria to find, in the adult, in a portion of the maxillary, the true incisive bone of the *Mammiferae*. He confirmed this view of the matter by proving that in the child at its birth the two bones are separate and distinct, and that the only difference that can be pointed out in regard to this is, that in man they are consolidated very early by the operation of life, whilst in the greater part of the *Mammiferae* they unite late, and in some not at all. This discovery of Goethe, although bearing upon a detail which may appear minute, has been of importance, inasmuch as his inquiry was one of the first conceived in this spirit of establishing analogies, an idea which has been so fertile in beautiful results. We have said already how long a time was necessary for the adoption of this opinion.

The principle of the head being composed of *vertebrae*, that remarkable application of the law of homology, had also struck Goethe before the time when first it was submitted to the examination of anatomists; but he did not publish his ideas respecting it, and consequently he cannot be considered as its author. We know that the bones of the skull, formerly considered as special formations, have subsequently to the beginning of this century been viewed in a different light by some naturalists. As the brain is the prolongation of the spinal marrow, so the skull is, according to these anatomists, the prolongation of the spinal column. The brain differs from the spinal marrow by its expansion; the skull differs from the *vertebrae* by a greater development of the superposed *laminae*

of the nervous system. In accordance with these considerations the skull has been decomposed into three vertebræ, and the face into three others, placed relatively to each other like the vertebræ of the body, but much more developed in the parts which envelop the brain, because this organ is much more developed than the spinal marrow. Thus these bones are no longer a special formation, but a repetition of the preceding formations.

M. Martius relates, in one of the notes which he has added to his translation, that the poet, as he walked in the cemetery of the Jews at Lido, near Venice, picked up on the sand the head of a ram, the skull of which was split longitudinally, and that whilst looking at it the idea instantly struck him that the face was composed of vertebræ; the transition from the anterior sphenoid to the ethmoid seemed evident to him at the first glance. This was in 1791, and at this time he did not make known his idea. Sixteen years later it was laid down by Oken that the head was composed of six vertebræ. According to Carus, this discovery may have been the result of an inspiration altogether resembling in its circumstances that of Goethe. Being in one of the ancient forests of the Brocken, Oken saw at his feet a stag's head perfectly bleached; he picked it up, turned it, examined it, and cried out, "'Tis a vertebral column!" M. Dumeril at the same time in France, from considerations entirely different, announced to the Institute the analogy of the head and the vertebræ,—an idea which was at this period received with astonishment and even with disapprobation.

We may moreover notice among the special labours of Goethe, his observations on the researches of Dr. Jægger upon the subject of the fossil bulls found in the neighbourhood of Stuttgart. Goethe seeks to prove in this article, that the differences which exist between fossil and recent bulls may be looked upon as the result of the perfecting of the species during the centuries which separate the two periods. His argument affords interest; but it seems to us that the poet plays almost as leading a part in it as the naturalist.

Goethe took great interest in the famous discussion raised in 1830 in the Academy of Sciences of Paris, upon the prin-

ciple which we have stated above. Every one remembers, that in these debates, perhaps the most remarkable that ever took place in a learned assembly upon a question relating to natural history, M. Cuvier, strong in his power of observation, his immense labours, and the rigour of his zoological method, denied to the unity of organic composition the right of being erected into a general law. He acknowledged it within certain limits, but would not admit of any other analogies than those which were rigorously demonstrated, and rejected all generalization conceived *a priori* and not yet proved by facts. M. Geoffroy St. Hilaire on his part, also attended by a numerous train of remarkable labours and important researches, gave himself up to his fancy, to predetermine the general laws of organization, which he conceived were revealed to him by those which are known. He required that the unity of organic composition should be recognised *a priori*, leaving to the progress of the science the business of demonstrating it in its details in succeeding ages. We have said enough to show that Goethe, with almost the entire body of German philosophers, rendering justice to the science and talents of the two illustrious champions, were sharers in Geoffroy's views of the subject. He has given his countrymen a history of this great struggle between analysis and synthesis; for he felt that it was a European question, and that it was agitated for Germany as well as for France. These two countries, ordained to march at the head of comparative anatomy* had till then but little understood each other, and Goethe saw well that this discussion was the beginning of a new æra, in which the synthetical ideas of the Germans would be more and more appreciated in France. The school at the head of which Geoffroy St. Hilaire placed himself was destined to bring about this union, in which the development of the science is so deeply interested. Goethe was happy in seeing this school appreciate the valuable labours of his countrymen and himself, and with the memoirs of this change his literary course terminated. The analysis of which we speak is the last work which came from the pen of this great writer.

* "Faits pour marcher à la tête," so says our author.—TRANSL.